CROP LOSSES DUE TO INSECT PESTS

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ESTIMATION OF CROP LOSS TO INSECT PESTS IN PULSES

W. REED

ICRISAT, Patancheru - 502 324, Hyderabad.

Andhra Pradesh, India

It is particularly Difficult for the pulses because many of these have the ability to compensate for losses, even at the podding stage. Two methods of crop loss estimation are available. (I) By recording the actual damage caused to the crop by the pests and Than estimating the yield loss that might be expected from that level of damage. (II) By measuring the "avoidoble loss", by Comparing violds from protected and unprotected plots. The problems in obtaining reliable estim area of crop loss from each of there methods are described.

There is an obvious need to quantify the yield losses caused by insect pests on our crops. Such loss estimates are required so that we can determine their relative importance and so decide upon the level of resources that should be devoted to research and pest management inputs for particular crop and pests. For few crops and pests the loss estimates may be simple but in the estimation of losses is far more complex, mainly because of the compensation for loss that can occur in most crops, particularly in the pulses. Pigeonpea (Cajanus cajan), and chickpea (Cicer arietinum), suffer losses to insect pests, but the quantification of those losses presents major difficulties.

Damage and compensation during the growth of the crop

Both pigeonpea and chickpea can suffer some loss of plants at the seedling and later stages to termites and other insect pests as reported by Sithananthan *et.al.* and Lateef in this workshop. However, most genotypes of both crops show marked plasticity to plant spacing, i.e. they grow to fill whatever space is available within quite wide limits. In chickpea the commonly recommended spacing is of 33 plants/m^2 but spacing trials have shown little variation in yield, particularly in pesticide free conditions, from densities ranging from 8 to 67 p!ants/m^2 (ICRISAT, 1980). Similarly with pigeonpea, a range of densities from 1.1 to 8.9 plants/m^2 showed small and inconsistent yield differences (ICRISAT, 1982). It is therefore likely that lost of a few plants, particularly in the early stages of growth, will have a little affect on yields, provided the initial seedling density is adeqate and any loss does not result in a patchy distribution of plants leaving gaps in the yields.

During the vegetative stage there is often a considerable loss of the leaf area of these pulses to a range of pests. It was found that chick pea and pigeon pea can withstand considerable levels of defoliation (upto 60% and 50% respectively) without significant loss of yield.

The pulses generally produce many more flowers and pods then can be held to maturity. In chickpea at ICRISAT (1978) it was found that the removal of *75%* of flowers gave only a 22% yield reduction. For pigeonpea, Sheldrake *et. al.* (1979) showed that the continuous removal of all flowers and young pods from alternate recomes and the removal of all flowers for the first 5 weeks of flowering resulted in little or no yield reduction. Both these crops will carry on producing flowers until a reasonable number of pods are held by the plant, so the loss of flowers or even young pods to early pest attacks can be adequately compensated, provided the growing conditions remain favourable.

The damage to large pods and seeds is more likely to results in substantial yield loss, possibly on a direct proportional basis, i.e. the loss of 20% of pods that are close to maturity or the loss of 205 of maturing seeds in those pods may result in a 20% crop loss. However, even this is not certain, particularly for pigeonpea, and experiments are in progress at ICRISAT to test this.

It is obvious, therefore, that simple observation of X% plant loss, Y% leaf end 2% fruiting body loss cannot be simply or directly translated to a quantified yield loss in these crops. How then can we quantity yield losses; how can we determine what the yield of pulse crop would have been if pests had not been present? The available literature including the FAO Manual en Crop Loss Assessment (Chiarappa, 1971) does not give any absolute guidance for this particular problem.

We would appear to have two options :- (a) to survey the actual damage caused by the pests in farmers' fields and then to estimate the losses caused by such damage experimentation, or (b) to measure the "Avoidable Loss" this being the yield difference between representative plots of the crop that have been protected (usually by pesticide use) from pest attack and others that have been left unprotected. Some of the problems that these two options present are as follows.

Estimation of crop loss from pest damage surveys

Damage by pests tends to vary, both geographically and seasonally as well through the life of an individual plant or crop. There is no way in which we can follow the progress and its pests so we have embark on a sample survey if we wish to obtain any knowledge of pest caused damage. There are several useful taxts that are concerned with such sampling including those by Southwood (1366) and Yates (5930). All that we have to do is to determine how, when, where and how much to sample.

The most obvious meant of sampling is to record the damage on a percentage basis, this usally quite simple but time consuming. When to sample brings in problems. We cannot afford to sample the crop oven large geographic areas at several times during the crop growth but if we sample at only one time we will probably miss much of the pest damage. Thus, *a* sample at the vegetative stage will give us some data on loss of leaf area and possibly or loss of plants, but will miss the damage that may be caused at the flowering and fuiting stage. By sampling later we will miss the early pest damage that may have caused significant loss if adverse growing conditions or continued rest attacks have prevented adequate compensation for the early damage. Here at ICRISAT we decided that, given the compensatory abilty of both pigeonpea and chickpeas, the damage caused to the pods is likely to be the most important source of pest caused loss, so most of our surveys have been carried out at the maturity stage of the crops when record the percentage of damage in the pods that are held by the plants at the time. The data from such surveys have obvious limitations. Percentage damage in pods is only one factor in the crop loss to pasts. We have no means of knowing how many pods would have been held by the plants if pests had not been present through the vegetative, flowering and fruiting stages of crops. However, by such sampling we at least establish a partial measure of crop loss and we can translate these data into approximations of minimum losses. *Heliothis armigera* the major pest of both of our crops usually totally destroys and pod on which it feeds, so *20%* pod damage by this pest will generally approximate to 20% yield loss, in addition to the unrecorded loss of flowers and young pods some of which may have been compensated. For a pest such as the pigeonpea podfly, however, damaged pods often contain harvestable seed for each larva attacks only one seed. Thus, *20%* pod damage by this pest may result in 5% loss in seed yield or less,. depending upon the number of seeds per pod and the mean number podfly damaged seeds per pod.

Where to sample was less of a problem, for we wanted to sample from the major pulse growing areas of India and so tried to do so given the obvious limitations of cost and manpower. Our sample sizes and numbers were directed by such limitations. We found great variation from area to area and year to year.

It might be possible to further refine the sample survey technique and to translate observed pest damage to actual crop loss estimates by further experimentation both on research stations and farmers' fields. However, such expermentation, would be of greater value if done in farmers' fields.

Estimation of avoidable losses

The most obvious method of determining yield losses caused by insect pests is to compare the yields of plots in which the pests are present with those in which pests are absent. In practice it is never possible to completely eradicate pest damage' even with twice-weekly spraying with very toxic pesticides, so we normally derive such data from plots in which damage is reduced to an acceptable minimum. The difference in yield between such unprotected and protected plots is commonly referred to as the "avoidable loss".

The measurement of avoidable loss appears to be quite simple. As is well established with tests of other inputs such as fertilizers, it would appear 10 be a simple, if expensive, exercise to set-up pairs of plots in farmers' fields across India, to protect one of each pair and then measure the difference in yield. Unfortunately plant protection is never simple for there is always interaction with other Factors. Although the pesticide use is intended to control only *one* or more pests, the chemical will also affect other fauna, including natural enemies and other pests, and the plant itself.

Pests and their natural enemies are mobile and their dispersal from the unprotected plot to the protected plot will affect the pest damage and yields in both the plots. This "interplots effect" which was well described for cotton by Joyce & Roberts (1959) and further investigated by Reed (1976) can lead to greater or lesser losses than would normally occur in the absence of the treated plot, according to the mobility of the pesthi (Reed, 1972). Most insecticide trial or demonstration plots tend to be much loss than a 0.25 hectare each, but Joyce and Roberts (1959) showed that plots of three hectares separated by 1 50 metres may be necessary to overcome interplots effects. When such large plots are used, separated by such large distances, however, we are likely to encounter substantial difference in crop growth in the two plots, caused by soil and even local climate heterogeneity.

It is also possible for pesticides use to have deleterious effects on yield. Phytoxicity is not uncommon, for example we have often seen pigeonpeas badly scorched by carbaryl and reduction in the pollinating insects can reduce yields in some crops (Free, 1S70).

We also face a problem in deciding which agronomic practices to follow when setting up the paired plots. The optimum agronomic practices for pesticide treated crops can be very different from those for unprotected crops. More then 90" of the chickpea and pigeonpea in India are left unprotected and most are of land race cultivars at low plant density with no irrigation or fertilizer use. Insecticide use on such crops may provide major yield increases but much greater yield increases will be obtained from high yielding cultivars sown at greater plant densities with inputs *of* fertilizer and irrigation (Reed. 1976). What should we test? Plots grown at the low input level with and without pesticide or those with a high input package? We will obtain *very* different "avoidable losses" from these two systems.

CONCLUSION

Their appear to be no simple and easy means of measuring pest caused losses in crops such *as* pulses where compensation for damage can and does occur. In addition the pulses are grown over a wide range of geographical and agronomic conditions, including intercropping. This will ensure that losses will have to be calculated for each individual agronomic circumstance, geographic area and according to the climatic circumstances of the particular season, for it is also obvious that there are large season to season varations in pest attack in any particular area.

By a combination of sample surveys of pest damage and carefully planned comparisons of paired plots, to determine avoidable losses, it might be possible to produce reasonable estimates of crop loss across India, but the cost of doing so would be very great in terms of both cash and manpower. Alternatively the use of producation function analysis using survey data as suggested by Pinstrup, Anderson *et. al.* (1976) may be of use.

The basis of pest management in the future must be the "economic threshold" and to quantify this we have to determine the crop loss associated with differing levels of pest (and natural enemy) infestations.

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